

en même temps que cette note, un spécimen de copie faite en suivant ces prescriptions, du réseau 8 cm. x 8 cm. que j'emploie à Toulouse pour les clichés de Nébuleuses et d'amas, photographiées au grand réflecteur de l'observatoire.

Pour qu'on puisse apprécier le degré de précision obtenu, je donne les résultats de quelques mesures faites sur le réseau et sur une copie.

Intervalle des traits 11-14.		Intervalle des traits 40-43.	
Réseau.	Copie.	Réseau.	Copie.
7 tours, 507	7 tours, 504	7 tours, 498	7 tours, 495
502	500	497	501
506	501	496	499
501	501	496	500
500	500	500	502
Moyennes... 7 tours, 5032	7 tours, 5032	7 tours, 4992	7 tours, 4994

Le tour de vis vaut à peu près un millimètre. On voit que l'écart entre le réseau et la copie est négligeable pour le travail courant de la photographie astronomique.

Je signale, en terminant, un dernier avantage d'une telle copie. Sa valeur commerciale, pour ainsi dire, nulle, la rend accessible sans dépense à l'astronome amateur.

Toulouse : 1905 novembre 10.

### *Position of the Axis of Mars.* By Professor Percival Lowell.

(Communicated by A. C. D. Crommelin.)

In 1905 the same course was pursued in the determination of the position of the Martian axis by measurement of the north polar cap as in the previous oppositions of 1903 and 1901. As the arctic spring haze lasted longer than in 1903, and the post-opposition phase invaded the north polar limb earlier, not so many observations could be secured. These began on April 7 and were continued to June 1, opposition having occurred on May 8. All the measures after this latter date were theoretically affected by the phase encroachment and those after May 17 sensibly so. The correction for this, so far as it is calculable from the difference between the tangent supposed taken on the limb and really taken along the phase ellipse, has been applied. The alteration due to lack of light there is no means of estimating.

E 2

Tabulated the measures follow :

Date.	M.S.T.	Position-angle.	wt.	$\lambda$ .	Date.	M.S.T.	Position-angle.	wt.	$\lambda$ .
	h m					h m			
April 7	16 24	128°2	4	297°5	May 10	10 49	127°6	2	282°8
9	14 55	128°3	3	257°7	11	10 40	128°8	3	271°8
12	16 8	128°9	4	248°5	11	56	129°7	4	290°4
13	14 39	127°3	2	217°8	12	10 36	129°9	4	262°1
15	14 18	125°5	3	194°8	11	50	129°3	4	280°1
	32	124°4	3	198°2	16	11 32	130°4	3	240°6
	37	126°1	2	199°4	17	12 39	128°7	2	248°1
17	14 0	127°3	2	172°5	21	11 39	128°0	3	198°3
	50	125°5	3	184°7	22	10 55	126°1	3	178°8
	16 0	126°9	3	201°8	23	10 57	124°0	2	170°4
19	14 31	124°3	3	162°2	24	11 0	125°0	3	162°3
	15 12	128°1	3	172°2		20	125°7	5	167°2
24	14 14	126°4	4	113°7		46	126°7	5	173°5
26	13 54	126°1	2	91°1	26	9 49	126°4	4	127°3
	14 30	127°0	2	99°9		10 38	125°9	3	139°2
30	13 48	126°1	2	54°3	30	11 18	129°5	4	113°5
May 5	11 40	126°9	3	339°1		12 15	129°2	2	127°4
	12 12	127°1	4	346°9					
7	10 57	126°2	3	311°1					

In the discussion three methods have been employed :

- (1)  $dp$  has been found from the pre-opposition measures only ;
- (2) from the measures to May 17 inclusive ;
- (3) from all measures, those after opposition having had applied the correction to the tangential angle due to the phase ellipse.

The three resulting values of  $dp$  are :

- (1)  $-1^{\circ}64 \pm 0^{\circ}22$  ; (2)  $-1^{\circ}49 \pm 0^{\circ}21$  ; (3)  $-1^{\circ}73 \pm 0^{\circ}20$

With these several values of  $dp$ , P has been corrected for the corresponding epoch :

1	Epoch	1905 April 23 ...	...	...	36°66
2	„	1905 April 28 ...	...	...	36°99
3	„	1905 May 4 ...	...	...	36°97

and the resulting great circles successively compared with those from 1901 and 1903 to the following determinations of the position of the Martian axis :

		Axis.		Tilt of Martian Equator to Martian Ecliptic.
		R.A.	Dec.	
1	1905 Before Opposition and 1901	315° 51'	54° 6'	23° 35'
2	1905 Through May 17 and 1901	315 57	53 58	23 43
3	1905 All, Corrected and 1901 ...	315 47	54 11	23 29
1	1905 Before Opposition and 1903	317 9	54 17	23 59
2	1905 Through May 17 and 1903	317 28	54 9	24 11
3	1905 All, Corrected and 1903 ...	317 2	54 20	23 55

And in addition :

1905 Before Opposition and 1903 before Opposition ...	317 18	54 18	24 2
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There is a close accord *inter se* in both sets of 1, 2, and 3, showing that the corrections are not vital. Between the two sets, however, there is a difference difficult to explain.

	R.A.	Dec.	Tilt.
The mean of 1901 and 1905 is :	315° 52'	54° 5'	23° 36'
that of 1903 and 1905 :	317 13	54 15	24 2

For the position of the vernal equinox of the planet we have :

		R.A.	Dec.
1	1905 Before Opposition and 1901 ...	84° 47'	24° 28'
2	1905 Through May 17 and 1901 ...	84 39	24 27
1	1905 Before Opposition and 1903 ...	86 36	24 33
2	1905 Through May 17 and 1903 ...	87 50	24 37

of which the means of the sets are respectively :

R.A.	Dec.		R.A.	Dec.
84° 43'	24° 27'	and	87° 13'	24° 35'

The data derived from 1901 and 1903 (Lowell Observatory Bulletin, No. 9) for epoch 1905 are :

		Axis.		Tilt.	Vernal Equinox.	
		R.A.	Dec.		R.A.	Dec.
1903	Expurgated and corrected for setting on phase ellipse and 1901 ...	315 8	55 3	22 37	85 52	24 32
1903	Before and after Opposition, expurgated and corrected...	315 58	54 40	23 13	86 2	24 33

The means for all four sets, viz. 1901-1903, 1903 before and after opposition, 1901-1905, and 1903-1905, are :

Axis.		Tilt of Martian Equator to Martian Ecliptic.	Martian Vernal Equinox.	
R.A.	Dec.		R.A.	Dec.
316° 3'	54° 31'	23° 22'	85° 57'	24° 32'

The result nearest to this is Lohse's, derived from measures on the north polar cap in 1884, 1886, and 1888, of which the mean is :

Axis.		Tilt.
R.A.	Dec.	
316° 45'	54° 31'	23° 39'

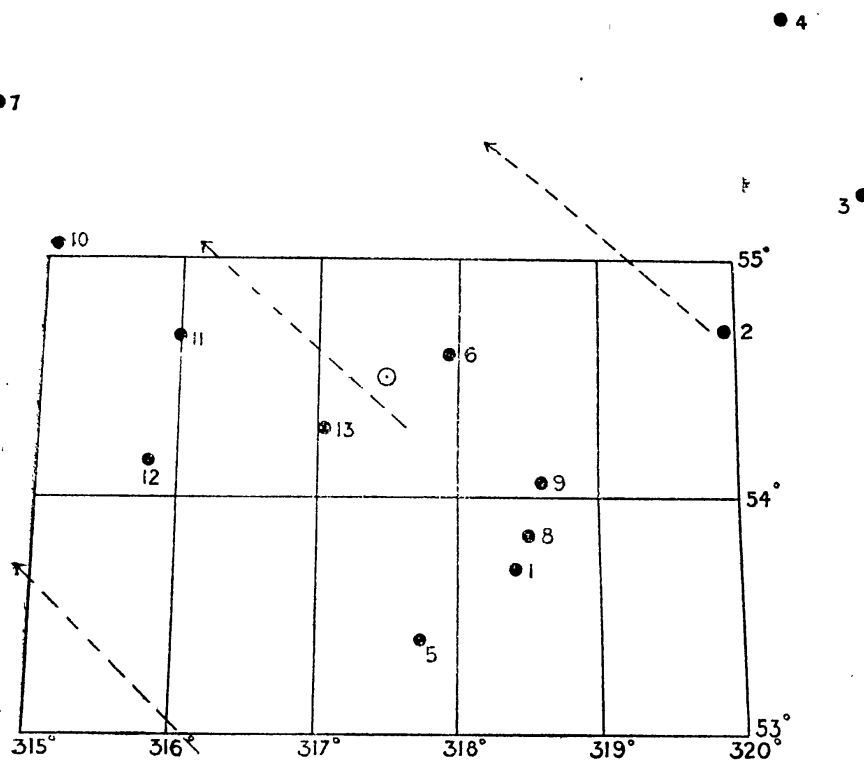
Schiaparelli's, Lohse's, and Cerulli's determinations have been completed and brought up to the epoch 1905 May 1 by taking account of the precession of the equinoxes. The correction for the Martian precession of the equinoxes has also been applied to the older determinations of the position of the axis of *Mars* to bring them down to date. This last as given by Struve, 7''·07 per annum, amounts only to six tenths of a minute in declination and three tenths in right ascension for twenty-six years. The results, together with Struve's and the writer's, are given in the following table :—

				Axis.		Tilt of Equator to Martian Ecliptic.
				R.A.	Dec.	
1 S.	1877-1879 (Schiaparelli)	...	...	318° 25'	53° 40'	24° 57'
2 N.	1882-1884	„	...	319 52	54 42	24 50
3 N.	1882-1886	„	...	320 56	55 17	24 52
4 N.	1884-1886	„	...	320 22	56 0	24 9
5 N.	1884-1886 (Lohse)	...	...	317 43	53 24	24 51
6 N.	1884-1888	„	...	317 52	54 36	24 3
7 N.	1886-1888	„	...	314 39	55 34	22 4
8 S.	1892-1894	„	...	318 31	53 51	24 51
9 S.	1896-1898 (Cerulli)	...	...	318 38	54 4	24 45
10 N.	1901-1903 (Lowell)	...	...	315 8	55 3	22 37
11 N.	1903 Before and after Opposi- tion (Lowell)	...	...	315 58	54 40	23 13
12 N.	1901-1905 Complete corrected (Lowell)	...	...	315 47	54 11	23 29
13 N.	1903-1905 Complete corrected (Lowell)	...	...	317 2	54 20	23 55
14	Struve (Satellites)	...	...	317 18	52 39	25 13

These several values have been plotted and appear in the following chart, the adopted mean position for the pole being denoted by the sign  $\odot$ . The arrows indicate the direction of the pole of the Martian ecliptic.

Measures of the position of the cap in the drawings by the

writer in 1903 (Bulletin No. 18) show a correction to be needed to the ephemeris tilt, diminishing that tilt by  $1^{\circ}7$  ; thus making the value  $23^{\circ}5$  instead of  $25^{\circ}2$ , as deduced and used in the ephemeris.



●14  
Position of the Pole of Mars.

The writer was therefore minded to see what Schiaparelli's drawings might have to say on the subject. He measured accordingly the drawings published by Schiaparelli in his fifth and sixth Memoirs, the only ones available for the purpose, and found that they placed the centre of the cap as follows :

1886.					
Drawing No.	Lat. Centre of Cap.	Position of Pole as in Centre of Cap on the Disk.	Ephemeris Pole on the Disk.	Difference.	$\lambda$
I.	67°3	22°6	21°8	- 0°8	Not given on drawings,
II.	66°4	23°6	21°8	- 1°8	
III.	66°8	23°2	21°9	- 1°3	
IV.	68°2	21°8	21°9	+ 0°1	
				- 3°8	
	Mean	...	...	- 0°9	

1888.					
Drawing No.	Lat. Centre of Cap.	Position of Pole as in Centre of Cap on the Disk.	Ephemeris Pole on the Disk.	Difference.	$\lambda$ .
VII.	70°4	19°6	24°7	+ 5°1	10
VIII.	66·7	23·3	24·8	1·5	350
IX.	68·9	21·1	24·8	3·7	340
X.	66·7	23·3	24·8	1·5	320
XI.	67·9	22·1	24·8	2·7	300
XII.	70·6	19·4	24·8	5·4	300
XIII.	67·1	22·9	24·9	2·0	240
XIV.	67·8	22·2	24·9	2·7	220
				24·6	
Mean				... .. + 3·1	

It might be argued that the drawings of the latter opposition are the better as with each opposition a draughtsman grows more proficient. But assuming all to be of equal weight, we have from the drawings of both oppositions an excess of tilt of ephemeris over observation of 1°·7, supposing the centre of the cap upon the pole. Now, in his *Memoria IV.*, Schiaparelli gives for the position of this centre a displacement of 2°·69 in  $\lambda$  323°·5, and, in his *Memoria V.*, of 1°·269 in  $\lambda$  295°·1. Comparing the longitudes of the drawings in 1888, we see that in most of them the centre was on the south side of the pole, which would increase the apparent polar tilt, not decrease it. The irradiation would do likewise. That the drawings indicate a tilt less than the ephemeris in spite of both these factors strengthens the conclusion that that tilt is too large. Indeed, in the future the tilt is more likely to be yet further reduced than increased.

From all these determinations the most probable position of the pole of the Martian equator seemed to the writer, after consultation with Mr. Crommelin, to be :—

R.A. 317°·5 and Dec. 54°·5. Epoch 1905. Tilt of  
Martian Equator to Martian Ecliptic 23° 59'.

The above value has been adopted for physical ephemerides of the planet in the British *Nautical Almanac*, beginning with that for the opposition of 1909.

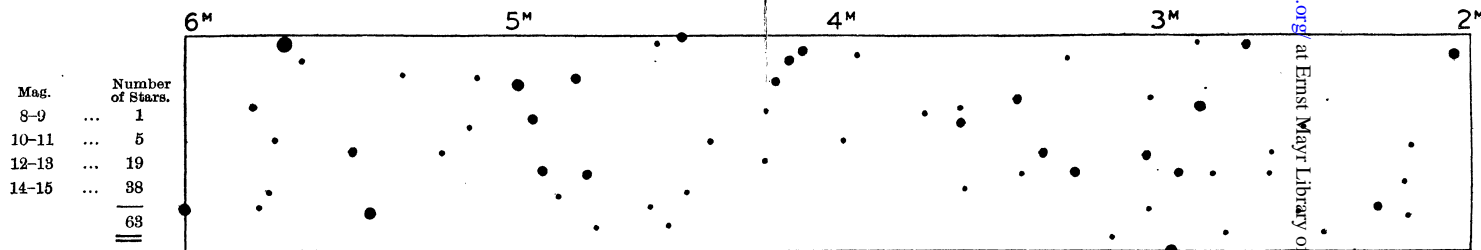
REGION following  $\delta$  Ophiuchi. R.A. 16h. 9m, Dec.  $-3^{\circ} 27'$ .

Chart of the U.S. Naval Observatory, Washington, with 26-inch glass.

E. S. HOLDEN, del.

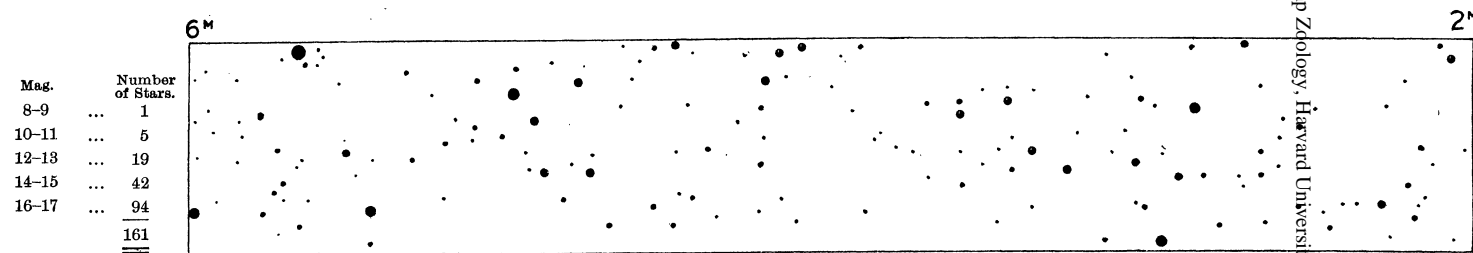


Chart of the Lick Observatory, Mount Hamilton, with 36-inch glass.

R. H. TUCKER, Jun., del., 1894.

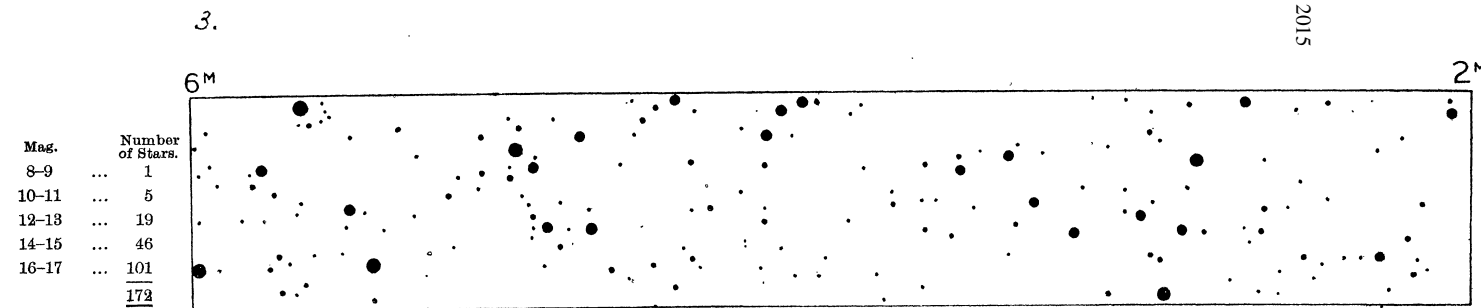


Chart of the Lowell Observatory, Flagstaff, Arizona, with 24-inch glass.

PERCIVAL LOWELL, del., 1905.